WHAT IS CLAIMED IS:

1. A soft decision decoder comprising:

a plurality of log likelihood ratio calculators for using a receive signal y with noise input from a receiver so as to perform soft decision decoding on a QAM (quadrature amplitude modulation) signal, reflecting of channel estimation errors, and calculating of a log likelihood ratio of a positive number and a negative number;

a subtractor for determining a difference between the positive signal and the negative signal output by the log likelihood ratio calculators; and

a comparator for receiving a calculation result on the difference of the log likelihood ratio of the subtractor, and determining the QAM signal to be positive or negative according to a positive/negative state of the calculation result.

2. The soft decision decoder of claim 1, wherein the log likelihood ratio calculator comprises:

M multipliers for receiving a channel estimate $\hat{a}$ estimated by the receiver, and receiving M reference signals x_i from a transmitter to respectively multiply them;

M subtractors for receiving M multiplication values multiplied by the multipliers to subtract them from a receive signal y received from the receiver;

M first square calculators for respectively squaring M subtraction values subtracted by the subtractors;

M second square calculators for receiving the reference signals x_i to

respectively square them;

M adders for respectively adding M square values of the reference signals input by the second square calculators and a ratio ρ of a symbol noise bandwidth of a QAM signal and a channel estimation filter noise bandwidth;

M dividers for dividing M square values input by the first square calculators by the M addition values input by the adders 122; and

a comparator for selecting the minimum value from among the M division values input by the dividers 123, and outputting a log likelihood ratio.

3. A log likelihood ratio calculator for soft decision decoding, comprising:

M multipliers for receiving a channel estimation value $\hat{a}$ estimated by the receiver, and receiving M reference signals x_i from a transmitter to respectively multiply them;

M subtractors for receiving M multiplication values multiplied by the multipliers to subtract them from a receive signal y received from the receiver;

M first square calculators for respectively squaring M subtraction values subtracted by the subtractors;

M second square calculators for receiving the reference signals x_i to respectively square them;

M adders for respectively adding M square values of the reference signals input by the second square calculators and a ratio ρ of a symbol noise bandwidth of a QAM signal and a channel estimation filter noise bandwidth;

M dividers for dividing M square values input by the first square

calculators by the M addition values input by the adders 122; and

a comparator for selecting the minimum value from among the M division values input by the dividers 123, and outputting a log likelihood ratio for soft decision decoding in consideration of channel estimation errors.

4. The log likelihood ratio calculator of claim 3, wherein the log likelihood ratio output by the comparator is given as follows:

$$\tilde{\gamma}(c_i) \approx \ln \frac{\max\limits_{x^+ \in \{x : c_i = +1\}} \left\{ \exp\left(- \frac{|y - \hat{a}x^+|^2}{|x^+|^2 \sigma_e^2 + \sigma_n^2} \right) \right\}}{\max\limits_{x^- \in \{x : c_i = -1\}} \left\{ \exp\left(- \frac{|y - \hat{a}x^-|^2}{|x^-|^2 \sigma_e^2 + \sigma_n^2} \right) \right\}} \gtrless 1$$

$$= \max_{x^+ \in \{x c_i = +1\}} \left\{ - \frac{|y - \hat{a}x^+|^2}{(|x^+|^2 + \rho)\sigma_e^2} \right\} - \max_{x^- \in \{x c_i = -1\}} \left\{ - \frac{|y - \hat{a}x^-|^2}{(|x^-|^2 + \rho)\sigma_e^2} \right\} \gtrless 0$$

$$= \min_{x^- \in \{x c_i = -1\}} \left\{ \frac{|y - \hat{a}x^-|^2}{|x^-|^2 + \rho} \right\} - \min_{x^+ \in \{x c_i = +1\}} \left\{ \frac{|y - \hat{a}x^+|^2}{|x^+|^2 + \rho} \right\} \underset{-1}{\overset{+1}{\gtrless}} 0$$

where $\rho = \frac{\sigma_n^2}{\sigma_e^2} = \frac{BW_n}{BW_e}$, BW_n is a QAM signal symbol noise bandwidth, and BW_e is a channel estimation filter noise bandwidth.

5. A method for calculating a log likelihood ratio for soft decision decoding, comprising:

(a) receiving a channel estimation value $\hat{a}$ estimated by a receiver, receiving M reference signals x_i from a transmitter to respectively multiply them, and receiving multiplication values to subtract them from a receive signal y

received from the receiver;

(b) respectively squaring subtraction values and the reference signals x_i in (a);

(c) respectively adding square values of the reference signals input in (b) and a ratio ρ of a symbol noise bandwidth of a QAM signal and a channel estimation filter noise bandwidth;

(d) dividing square values of the subtraction values input in (b) by the addition values added in (c); and

(e) selecting the minimum value from among the values input in (d), and outputting a log likelihood ratio for soft decision decoding in consideration of channel estimation errors.

6. The method of claim 5, wherein outputting a log likelihood ratio in (e) follows the subsequent equation.

$$\tilde{\gamma}(c_i) \approx \ln \frac{\max_{x^+ \in \{x : c_i = +1\}} \left\{ \exp\left(- \frac{|y - \hat{a}x^+|^2}{|x^+|^2 \sigma_e^2 + \sigma_n^2} \right) \right\}}{\max_{x^- \in \{x : c_i = -1\}} \left\{ \exp\left(- \frac{|y - \hat{a}x^-|^2}{|x^-|^2 \sigma_e^2 + \sigma_n^2} \right) \right\}} \gtrless 1$$

$$= \max_{x^+ \in \{x\, c_i = +1\}} \left\{ - \frac{|y - \hat{a}x^+|^2}{(|x^+|^2 + \rho)\sigma_e^2} \right\} - \max_{x^- \in \{x\, c_i = -1\}} \left\{ - \frac{|y - \hat{a}x^-|^2}{(|x^-|^2 + \rho)\sigma_e^2} \right\} \gtrless 0$$

$$= \min_{x^- \in \{x\, c_i = -1\}} \left\{ \frac{|y - \hat{a}x^-|^2}{|x^-|^2 + \rho} \right\} - \min_{x^+ \in \{x\, c_i = +1\}} \left\{ \frac{|y - \hat{a}x^+|^2}{|x^+|^2 + \rho} \right\} \underset{-1}{\overset{+1}{\gtrless}} 0$$

where $\rho = \frac{\sigma_n^2}{\sigma_e^2} = \frac{BW_n}{BW_e}$, BW_n is a QAM signal symbol noise bandwidth, and BW_e is a channel estimation filter noise bandwidth.